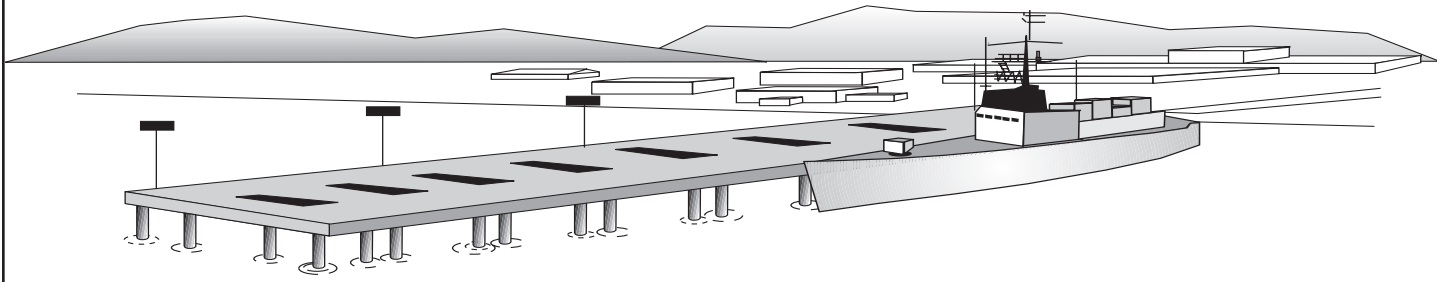


On The Waterfront

A Publication of the Shore Facilities Department

Volume 1.4



NAVY
Naval Facilities Engineering Service Center

High Payoff Technologies Will Cut Infrastructure Maintenance Costs

In FY99 NAVFAC and CNO N-44 will begin a program to demonstrate and validate recently developed technologies that, when fully implemented, will save millions of dollars in the maintenance and repair of Navy facilities. These savings will accrue from using high performance materials or construction systems that afford lower life cycle costs for new construction or that give longer lasting repairs.

Analysis of claimant Base Reports and planned MCON projects indicated that Real Property Maintenance (RPM) dollars could be saved by implementation of high performance material technologies in the areas of Concrete (general construction and pavement), Roofing, Composites, and Corrosion Protection (coatings and cathodic protection). NFESC has assigned teams to evaluate technical opportunities in these areas and to propose demonstration and validation (DEMVAL) projects. Selection of DEMVAL projects will be based on the projected Navy benefit, RPM cost reduction, and the willingness of a Navy activity to collaborate in the demonstration. The projects will be co-funded by the participating activities and the DEMVAL program.

Team leaders for the technology areas are all members of NFESC. They are:

- Concrete (structures) - **Javier Malvar**, DSN 551-1447
- Concrete (pavements) - **Charlie Schiavino**, (610) 595-0597
- Composites - **Javier Malvar**, DSN 551-1447
- Roofing - **Dan Zarate**, DSN 551-1057
- Corrosion Protection - **Dan Polly**, DSN 551-1058

Team leaders are coordinating with the **National Science Foundation**, the **National Institute for Science and Technology**, industry trade organizations, and academic institutions to identify candidate technologies. They are seeking high payoff technologies that have passed feasibility



New technologies show promise for reducing cost of roofing maintenance and repairs.

testing but require large scale field testing to validate constructability and performance characteristics.

NFESC has contracted with the **Civil Engineering Research Foundation (CERF)** of the **American Society of Civil Engineers** to coordinate industry participation in the DEMVAL. CERF participation will ensure that performance-based criteria are developed that will foster acceptance and use by the A&E and materials processing/fabricating communities.

Some of the DEMVAL technologies are described on NFESC's homepage under the heading "Cost Reduction Opportunities."

Please contact one of the people listed if you are aware of a technology that you think has potential for high payoff in one or more of your activity's projects and are interested in validating its effectiveness.

For further information, contact any of the team leaders or **Preston Springston**, ESC60PM, at DSN 551-1225, (805) 982-1225, or email: pspring@nfesc.navy.mil.

LANTDIV Designs "Standard" High Performance Magazine

Owen Hewitt is leading a team of LANTDIV engineers who are developing a standard design for a High Performance (HP) Magazine. The standard design will be **Department of Defense Explosives Safety Board (DDESB)** certified and will require only site adaptation for specific locales. A budgetary cost estimate is being prepared in conjunction with the standard design. LANTDIV has contracted **Sverdrup Civil Inc.** to design the operating system that will automatically open and close pit covers that provide security and protection to stored ordnance. The **Navy Crane Center** is developing specifications for the overhead bridge crane which moves ordnance between the magazine's shipping and receiving area and storage cells. The Packaging, Handling, Stowage, and Transportation (PHS&T) center at **Naval Weapons Station Earle**, New Jersey, has developed drawings and specifications for a Universal Straddle Carrier that will be used as an attachment by the overhead bridge crane to lift all Navy palletized and containerized ordnance. The standard design is scheduled for 35 percent completion by the end of March 1998, and will be completed in December 1998. **Bill Gibbings**, NAVFAC's Ordnance Facility Criteria Manager, is managing the HP Magazine implementation process. The DDESB has issued a preliminary approval of the HP Magazine. **Jim Tancreto**, of NFESC, will present the design and siting criteria for final approval by April 1998.



Acceptors post test (MK103, WAU-17 and MK107 warheads in the foreground; MK82 and MK83 bombs in the background). No acceptors were detonated by the donor explosion.

Successful Final Test

Certification testing of the HP Magazine was successfully completed on October 23, 1996, in the Mojave desert at the **Naval Air Warfare Center, China Lake**, California. The test detonated 60,000 pounds net weight of explosives (288 MK82 and 4 MK84 bombs) to prove conclusively that the design of the HP Magazine prevents sympathetic detonation of ordnance stored in compartmentalized storage cells. Test observers included: **Chester Canada** and **Ray Sawyer** of DDESB; **CAPT Lee Champagne**,

Commanding Officer, Fleet Activities Sasebo, Japan; **CAPT Patrick Madison**, **Commanding Officer, NAF El Centro**, California; **Michael Swisdak** of **NSWC Indian Head Division**; and delegates from the **Naval Facilities Engineering Command**, **Ministry of Defense Singapore**, and **Eglin Air Force Base**. **CAPT John Walsh**, **CINCLANTFLT Ordnance Officer**, represented both the Atlantic and Pacific Fleets during a post-test inspection of the site.

To many of the observers it seemed impossible that the "acceptor" ordnance (i.e., bombs, torpedo warheads, underwater mines, Air Sparrow warheads, and projectiles) stored in cells adjacent to the detonating "donor" ordnance would not be detonated by the incredible force of the explosion. The experts who inspected the acceptor ordnance and reviewed the test data found that no sympathetic detonation had occurred. Some of the thin-skin ordnance had burned, which was an acceptable reaction. There was pressure rupture of one MK82 bomb case and deflagration of one M107, 155mm projectile, resulting from their close proximity to burning, thin-skin ordnance. These limited, late-time reactions did not violate pre-established safety criteria. Pressure and debris data were consistent with the Department of Defense data base for earth-covered magazines that store 60,000 pounds net explosive weight (NEW). Thus, the objective was met for design of a magazine that could store at least 300,000 pounds NEW, while having the explosives safety quantity distance (ESQD) arc (1,370 feet) of a magazine that stores only 60,000 pounds NEW.

High Performance

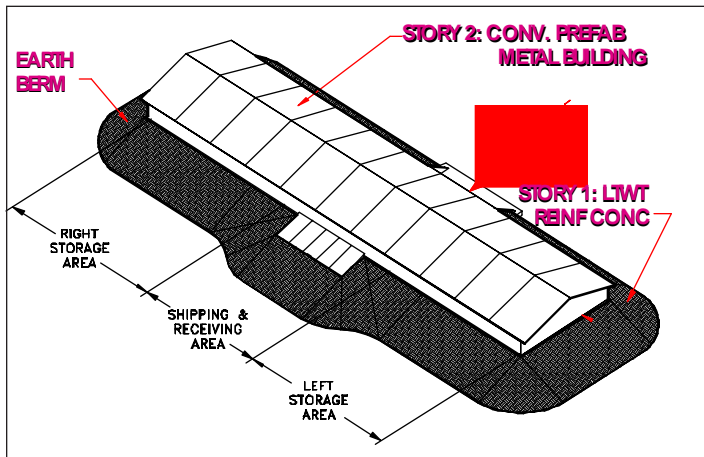
The non earth-covered HP magazine requires less standoff distance to inhabited buildings or public roadways than a conventional earth-covered magazine (see table below). Previous magazine technology limited the net explosives storage density to about 371 pounds per acre of encumbered land. The HP Magazine increases this to 2,222 pounds per acre, thereby dramatically reducing encumbered land. Earth berms extend only to the top of the HP magazine's ordnance storage pits. A lightweight, pre-engineered metal building provides protection from the weather when loading and unloading ordnance.

Comparison of magazine storage efficiencies

Storage NEW (lb)	Standard Magazine		HP Magazine		
	ESQD Arc (ft)	Area (acres)	ESQD Arc (ft)	Area (acres)	Saved Area (%)
300,000 (mixed)	3,350	809	1,370	135	83
150,000 (missile)	2,175	341	1,250	113	67

(continued on next page)

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Isometric view of HP Magazine.

The “high performance” of the HP magazine comes from reducing the maximum credible event (MCE) that is used to establish the ESQD arc. Ordnance is stored in pits that are divided by permanent walls that form an aisle for transporting ordnance from storage cells to the shipping and receiving area. The maximum NEW stored in any single location is 30,000 pounds. Munitions with a low density of explosives, such as missiles, will typically fill an entire storage pit without exceeding 30,000 pounds NEW. A pit can be subdivided into two storage cells by adding a relocatable wall. Each storage cell can safely hold up to 30,000 pounds NEW. Relocatable and permanent interior walls are designed to prevent

sympathetic detonation between individual storage cells and between any closed storage cell and the shipping and receiving area. The MCE in an HP magazine, which can store over 300,000 pounds NEW, does not exceed 60,000 pounds NEW, which is a combination of the explosives contained in any open individual storage cell and the shipping and receiving area.

Using an overhead gantry crane, a small crew can efficiently handle both containerized and palletized Navy ordnance including vertical launch system containers. A newly developed straddle carrier allows lifting of multiple pallets or containers to expedite ordnance handling. An internal shipping and receiving area enables pre-staging of ordnance and can serve as a barricaded area for temporary storage of loaded vehicles. The HP Magazine can accommodate delivery by either rail cars or trucks.

Implementation

An HP Magazine can be tailored for specific operation requirements to minimize acquisition cost. An initial cost estimate will be available at the end of March 1998 when the 35 percent standard design is completed. This cost estimate will be revised as the standard design progresses.

For further information contact, **Jim Tancreto**, ESC62, at DSN 551-1180, (805) 982-1180, or email: jtancr@nfesc.navy.mil.

ABOUT THE ESC

We are the Navy's Center for specialized facilities engineering and technology.

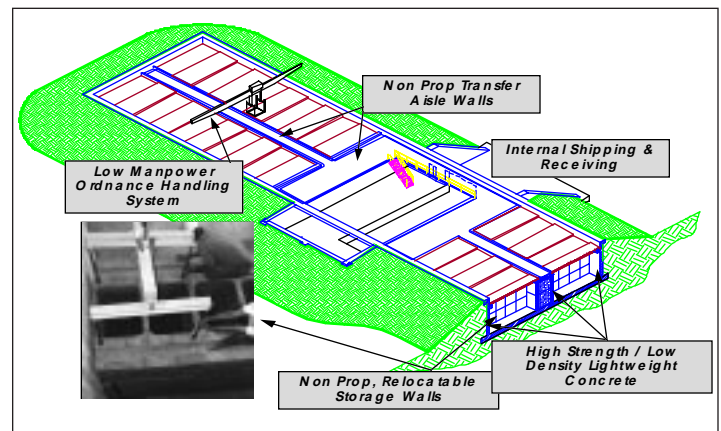
In partnership with our customers we deliver quality products and services in:

- Shore, Ocean, and Waterfront Facilities
- Environmental
- Amphibious and Expeditionary Operations
- Energy and Utilities

We provide solutions to problems through engineering, design, construction, consultation, test and evaluation, technology implementation, and management support.

We leverage technology to enhance the effectiveness and efficiency of our customers. We use existing technology where we can. We identify and adapt breakthrough technology when appropriate. We perform research and development when required to meet Navy and Marine Corps needs.

For more information, call toll free: **1-888-4 THE ESC** (1-888-484-3372). E-mail us at help@nfesc.navy.mil or join us on the Web at <http://www.nfesc.navy.mil>.



Cutaway isometric view with prefab metal building not shown.

On The Waterfront is an unofficial publication of the Shore Facilities Department, Naval Facilities Engineering Service Center, Port Hueneme, CA 93043-4370. Editorial views and opinions are those of the authors and not necessarily those of the United States Navy.

If you have any comments or questions, suggestions for future articles, or would like to receive copies of “On the Waterfront,” call or write to **Mr. Joe Connett, Code ESC60**, (805) 982-1570; DSN: 551-1570; FAX: (805) 982-3481, or Internet: jconnet@nfesc.navy.mil.



Composites Strengthen Navy Piers

The first of a series of three demonstration projects to apply external reinforcing to increase the strength of Navy piers was completed in December 1996. **Naval Station Norfolk** selected Pier 11 for the demonstration of strengthening methods, which used carbon-reinforced plastic laminated to the concrete deck. **Gordon Spence**, Deputy Staff Civil Engineer, stated that techniques to increase or restore strength of aged piers are attractive to the Naval Station because it is very difficult to program pier construction projects given the Navy's constrained budget.

Pier 11, which was originally designed for 70-ton truck mounted cranes, was rated for limited use of 90-ton cranes. The deck spans 20 feet, however, five decks which have electrical vaults span 22 feet. A recent A&E study found that the deck slabs in the portable crane operating lanes of the 22-foot spans had design shortfalls and recommended restricted operation of 70-ton cranes on these decks. The goal of the strengthening demonstration was to reinforce two crane operating lanes between bents 50 and 51 to allow unrestricted operation of 90-ton cranes. The project was jointly funded by the **Office of Naval Research** and Naval Station Norfolk.

Dr. George Warren led the NFESC team, which first assessed the existing condition and load capacity of Pier 11. The team then designed a graphite reinforced epoxy laminate composite overlay for the underside of the deck. Under subcontract to VSE Corporation, **SCI Services** installed a composite system manufactured by the Tonen Company on one side of the deck and **Structural Preservation Systems** installed a composite system manufactured by the Mitsubishi Company on the opposite side. NFESC and the **Virginia Polytechnic Institute and State University** installed strain and piezoelectric sensors for future monitoring of performance and condition of the hybrid

composite-reinforced concrete structure. The entire project was performed while the pier stayed in service and continued to support

USS Kearsarge (LHD-3), **USS Stennis (CVN-74)**, and **USS Enterprise (CVN-65)**. **Dave Stump** of the NAVSTA Staff Civil Engineers Office, coordinated the pier work with Port Operations, and **Eddie Theisz** coordinated PWC Norfolk's onsite support of the construction contractors.

NFESC load tested the upgraded deck slab to establish a baseline for comparison with performance data that will be collected in the future. The proof load tests verified that the upgrade reinforcement was integral with the deck and proved that no restrictions were required on 70- or 90-ton crane operations on the upgraded span.

The laminate overlay increased the service (cracked section) stiffness by 5 percent, increased the strength by 10 percent, restricts crack growth and protects the steel reinforcing from salt water corrosion. The upgrade extends the service life of the deck by approximately 20 years. NFESC will continue to test and evaluate the upgrade over the next two years.

The project demonstrated that graphite/epoxy laminate overlays can be used to extend the useful life of existing piers at substantial savings compared to deck replacement. Overlay cost

depends on capacity and amount of existing steel reinforcement of a deck. For the Norfolk project the overlay cost \$94 per square foot. Usually, only a small portion of a pier needs to be upgraded to meet mission requirements; only those decks that support crane lifts and then only the portions of those decks that are influenced by the crane outrigger loads. An added benefit to the fleet customer is that the pier can remain in use during the upgrade.

The next demonstration project is underway at Pier 12, a 47-year old structure, located at **Naval Station San Diego**. Twelve decks and 20 batter piles are being repaired and strengthened to support the operation of 50-ton cranes. NFESC completed a 100 percent design for the project. The **South Bay Area Focus Team (SBAFT)**, led by **Nelly Totty**, collaborated with NFESC on development of the Request for Proposal (RFP). The RFP is a design-build contract process that enabled contractor selection based on cost and technical qualification. This process allowed bidding contractors flexibility in their proposals to meet the specified strength reinforcing parameters and material performance

specifications.

During September 1997, the SBAFT awarded the design-build



Naval Station Norfolk Pier 11.



Application of carbon-epoxy laminate.

(continued from previous page)

contract to **William P. Young Incorporated**. William P. Young plans to use the **Hardcore Dupont** system of prefabricated, fiber-reinforced plastic (FRP) shells for pile reinforcement. Carbon rods manufactured by **DFI** will be inset into the top deck for reinforcement of negative moment areas. Pultruded uniaxial carbon strips manufactured by **Sika** with the **Fyfe & Associates** process for field impregnation of carbon tow sheets will be used for deck reinforcement in positive moment areas.

NFESC is completing the design for the third demonstration project at Wharf B25 at **NAVSTA Pearl Harbor**. This project will

use an impressed current cathodic protection system to stabilize corrosion to extend the service life by over 20 years and will strengthen the deck to support the operation of 50-ton cranes. The contract for this project is expected to be awarded by PACDIV late in FY98.

For further information, contact **Dr. George Warren**, ESC62, at DSN 551-1236, (805) 982-1236, or email: gwarren@nfesc.navy.mil.

Impressive Currents Arrest Corrosion

PACDIV and **NFESC** have specified the first use of impressed current cathodic protection methods for reinforced concrete to stop corrosion of a Navy pier. This technology is expected to extend the service life of Diego Garcia's Petroleum, Oil and Lubricant (POL) Pier 427 by 10 to 15 years.

The Diego Garcia pier was constructed in 1979 using local coral aggregates contaminated with chlorides. These aggregates, in combination with severe marine waterfront conditions, have produced extensive corrosion of the steel reinforcement. This corrosion has cracked and spalled the pier's concrete surface. Conventional repair methods would have lasted 1 to 3 years without addressing the source of the problem. The A&E recommended replacement of the pier at an estimated cost of \$32 million. **Doug Burke** of NFESC recommended an alternative \$5 million solution to PACDIV; the use of embedded titanium anodes to impress a direct current on the rebars to reverse the corrosion cell. Use of this new cathodic protection methodology provides extended corrosion protection for the entire reinforced concrete structure. The feasibility and effectiveness of the impressed current system was proven by NFESC under sponsorship from the **Office of Naval Research**. **Doug Burke** and PACDIV's **Mel Tsutahara** teamed together with the project A&E to detail the materials and the construction method for Pier 427. The Military Construction (MCON) contract was awarded to two contractors, which formed a joint British and US venture to accomplish the repair work.

Mel Tsutahara and **Bernard Wong** led the Navy design team to incorporate the new technology in the \$5 million project for a savings of \$27 million. NFESC's **Tom Tehada**, the NAVFAC Technical Consultant for Corrosion and Cathodic Protection, provided technical expertise on cathodic protection systems throughout the project.

The innovative cathodic protection system applied to Pier 427 will be used on other Navy piers in the near future.

Lyle Beller, of the **San Diego Naval Submarine Base**, is working

with NFESC to demonstrate a second generation system that combines impressed currents and sacrificial anode, to provide cathodic protection to both the deck and support piling of a portion of San Diego Subbase Pier 5002. This system, planned for installation in 1998, will extend the structure's life by more than 20 years at an approximate cost of \$30 per square foot. A third pier repair project is being planned for Wharf B25 in Pearl Harbor, which will use impressed current cathodic protection in



Diego Garcia POL Pier 427

combination with epoxy-carbon composites to stabilize corrosion and to restore deck and piling strength.

For further information, contact **Doug Burke**, ESC63, at DSN 551-1055, (805) 982-1055, or email: dburke@nfesc.navy.mil.

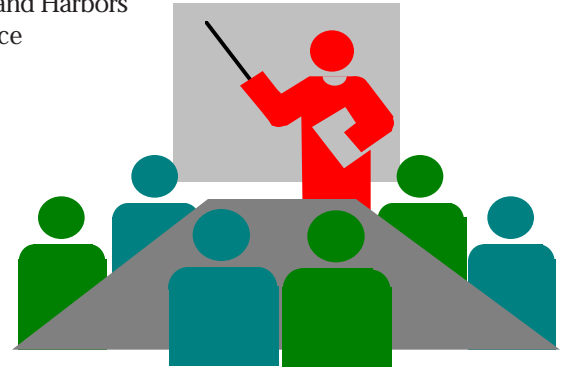


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Guest Column

Waterfront Technology User's Group Meeting

by
Dave Curfman
Special Assistant for Waterfront and Harbors
NAVFAC Criteria Office



The NAVFAC Waterfront Technology User's Group met in April 1997 for the latest in an series of successful meetings. This group furnishes an opportunity for EFD, EFA, and PWC engineers to provide guidance in the development of waterfront technology and criteria to ensure that they meet field requirements. Membership also includes engineers from NFESC, the Chief Engineer's Office, and the NAVFAC Criteria Office.

The Criteria Office funded the development and/or the transition-to-use of most of the projects presented at the meeting. It designed the sessions to critique the progress of the efforts and recommend future direction. Meeting highlights included presentations from the following NFESC engineers:

- **Duane Davis** (Waterfront Materials Division) - Advanced Fendering Concepts and Berthing Analysis Using Dynamic Techniques
- **David Hoy** (Waterfront Materials Division) - Composite Fender Pile Testing
- **Bill Seelig** and **Paul Palo** (Ocean Facilities Department) - New Mooring Manual with the Climatological and Ships Characteristics Databases
- **George Warren** (Waterfront Structures Division) - Innovative Pier Upgrade Methods, Pier Lateral Stability, and NWS Earle Pier Analysis
- **Doug Burke** (Waterfront Materials Division) - Waterfront Repair Materials
- **Dave Pendleton** (Waterfront Materials Division) - New Waterfront Maintenance Manual
- **Al Antleman** (Facilities Systems Division) - Collaborative Infrastructure Assessment Tool (CIAT)
- **John Ferritto** (Waterfront Structures Division) - Seismic Lifelines and Piers Guidance

Each presenter left with action items to ensure his project will provide the maximum benefit to field designers. As a result of the meeting, the Criteria Office and NFESC updated the Shore Facilities RDT&E Master Plan, which guides the technology development. From developing new berthing analysis techniques to testing recycled plastic fender piles and from developing a ships characteristics database to writing a new mooring manual, NAVFAC engineers continue to create the technologies required to support the fleet in the 21st century. The user's group is indispensable in achieving the overall mission of waterfront facilities support.

The next user's group meeting is scheduled in the fall of 1998. In the meantime, in March 1998, the ASCE will convene the Ports '98 Conference in Los Angeles, California. It's another display of the latest in waterfront technologies. NAVFAC is a cooperating organization and encourages your attendance.

Interested parties may obtain information about Ports '98 and minutes of the latest user's group meeting by calling **R. David Curfman** at DSN 262-4203, (757) 322-4203, or faxing a request to (757) 322-4416.

PUT US TO WORK FOR YOU!!



NFESC is an NWCF organization with some mission management components. To put us to work for you, call any of our members to develop a scope of work and cost estimate. We accept funds on SF2275 and SF2276.

NEWS FLASH

We have funding available to share the cost of implementing new technologies at your facility. See "Cost Reduction Opportunities" at www.nfesc.navy.mil.

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On the Waterfront

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